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THE RELIABILITY OF DETERMINING AGE OF RED ALDER BY RING COUNTS

by

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ABSTRACT

Examination of cross-sections of 54 red alder trees from 14 stands of varying age and site conditions indicated that abnormal rings (false, partial, or missing) occur infrequently. Rings may be indistinct and ring counting must be done with great care, preferably on prepared surfaces (cross-sections or cores) and under magnification and good lighting. With such preparations, ages of red alder trees can be determined with acceptable accuracy by conventional ring-counting procedures.

KEYWORDS: Ring counts, age determination (tree/stand), red alder, *Alnus rubra*.

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INTRODUCTION

An accurate assessment of tree and/or stand age is prerequisite to many forest management decisions. Age must be known in order to use site index curves and yield tables. Moreover, many silvicultural and ecological studies involve determination of tree age.

Ages of tree species growing in temperate zones can usually be determined by counting annual rings on stem cross-sections or increment cores. Some problems may exist, however. Annual rings in diffuse-porous hardwood species are less distinct than in conifers and ring-porous hardwoods. False rings (multiple rings within a single year) may be formed, especially when growth has been checked prematurely (e.g., by drought) and then has resumed within the same growing season (Zimmermann and Brown 1971). In addition, discontinuous (partial) and missing rings have been reported in many species under certain conditions (Chapman and Meyer 1949, O'Neill 1963, Larson 1956, Oliver 1975, Stubblefield and Oliver 1978). For most species, age can be determined with acceptable accuracy if cores or stem sections are carefully prepared (e.g., planed, polished, or stained) and examined under magnification and adequate light. When false or missing rings occur, "cross-dating" techniques (Stokes and Smiley 1968, Fritts 1976) used in dendrochronology permit accurate determination of age.

Concerns about age determination in red alder (*Alnus rubra* Bong.) were raised by Smith (1973, 1978) and by Newton (1978). The indistinctness of rings in red alder (a diffuse-porous hardwood) undoubtedly contributes to these concerns. Smith (1973), for example, revised his stump age estimate of 56 years to 75 years after examining a cross-section under a binocular microscope. He also pointed out that adjacent Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) were 96 years old and considered this good evidence that at least 21 rings were missing on the alder tree. The principal concern with age determination for alder voiced by Smith (1973) and by Newton (1978), therefore, appears to be the possibility of missing rings. Smith (1978) implied that date of stand origin (i.e., years since site disturbance) or age of associated Douglas-fir trees (Smith 1973) will provide the best estimate of the age of some red alders growing on a particular site. Newton (1978) also found some evidence for missing rings on a rather old alder tree (70+ years) and has suggested that large numbers of missing rings after age 40 may compromise efforts to measure growth by stem analysis. In 1973, Smith had pointed out that present site index curves and normal yield tables (e.g., Worthington et al. 1960) may be inaccurate if missing rings are a common occurrence in this species.

Recent work near Olympia indicates that alder patches or stands are frequently younger than adjacent Douglas-fir stands and that a considerable range in age may exist in alder stands which appear even-aged.[2] Stubblefield and Oliver (1978) have examined mixed conifer/alder stands in which the alder was several years younger than associated conifers. Kennedy and Elliott (1957) and Tessier and Smith (1961) also reported substantial age variation in red alder stands sampled for some of their studies. Though our results are somewhat supported by these three other studies, such findings are at variance with commonly stated and accepted beliefs concerning establishment of this fast-growing intolerant species; that is, that alder stands are essentially even-aged and that alder trees are as old as or older than Douglas-fir associated with them in mixed stands of natural origin. To scrutinize these findings and because of the importance of the age determination question, we decided to assess the accuracy with which age can be determined by counting rings of red alder.

[2] Data on file at Forestry Sciences Laboratory, Olympia, Washington.

METHODS

Cross-sections from 111 trees which had been collected in winter 1976-77 for other research were used in this study. The trees were growing in pure alder stands on 14 sites located within a 20-mile[3] radius of Olympia. Major characteristics of these sites and stands are listed in table 1. The individual trees represented a rather wide range in age (29 to 88 years), breast high diameter (7.1 to 16.5 inches), and height (53 to 112 feet). Although most trees were dominants and codominants, some intermediate and suppressed trees were sampled (about 10 percent of total). Cross-sections from trees at the first six sites were cut just above the root collar (0 to 6 inches); cross-sections of trees on the remaining sites were cut at stump height (about 1 foot above ground).

[3] See page 7 for metric equivalents.

All sections were planed for a clean, smooth surface. If annual rings were very close together (<0.02 inch), as was often the case in the outer portions of old or suppressed trees, a slanted cut was made by razor blade or gouge chisel to increase the "apparent width" of the rings. We then attempted to "date" all sections by using the technique described by Stubblefield and Oliver (1978). Essentially, this method involves locating the annual ring produced after the damaging freeze of November 1955 (Duffield 1956). Rings produced during the 1956 growing season were often much narrower and/or irregular (fig. 1). In addition, a dark brown or black line was commonly present between the 1955 and 1956 growth rings (fig. 2). Interior rot (fig. 3) or partial death of the cambium (fig. 4) was observed in a few instances. Once location of the 1956 ring was determined, we knew that 21 additional rings should exist between it and the bark. A greater number would indicate presence of false rings and a lesser number would indicate that some rings were missing. Rings were

Table 1--*Description of sites and stands from which cross-sections of red alder were collected*

Location	Elevation	Tree age: Mean	Tree age: Range	Average height	Estimated site index[1]	Number of trees sampled
	Feet	- - Years - - -		- - - - Feet - - - -		
Waddell Creek Road	1,000	42	41-43	78	84	4
Powderhouse Road	800	57	51-59	102	96	4
North Creek	300	53	46-56	103	100	4
Cedar Creek	400	39	32-44	94	105	4
Upper Sherman Valley	600	43	41-46	97	102	4
Lower Sherman Valley	500	55	47-63	93	84	4
McKenny	300	44	30-68	87	92	12
Porter	550	35	29-43	87	101	12
Rock Candy	900	45	31-66	82	86	12
McCleary	300	73	67-88	87	76	12
Taylor Towne	400	56	54-57	91	87	12
Schafer Park	325	54	50-60	96	93	12
Stillwater	250	59	45-69	72	67	12
Waddell Flat	400	46	44-47	2/	2/	3

[1] Based on: Norman P. Worthington, Floyd A. Johnson, George R. Staebler, and William J. Lloyd. 1960. Normal yield tables for red alder. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station Research Paper 36, 29 p. Portland, Oregon.

[2] Not available.

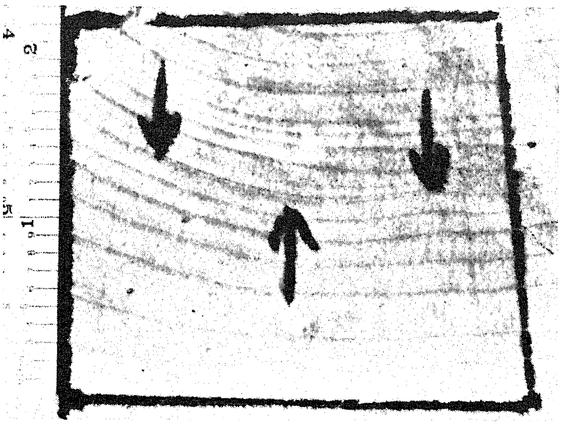

Figure 1.--A substantial reduction in width of the 1956 growth ring was common in many alder trees affected by the damaging freeze of November 1955.

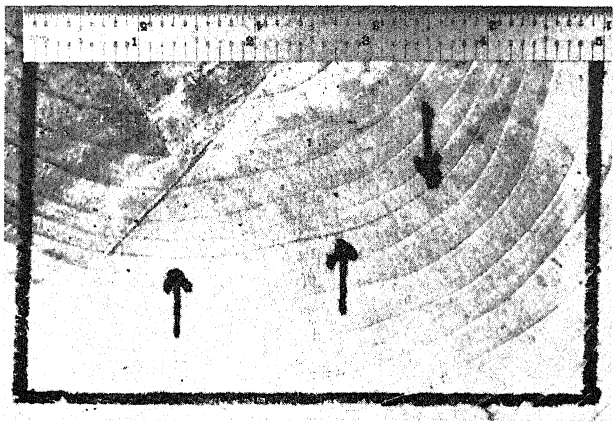

Figure 2.--Cambial growth was not reduced by the freeze in this alder, but a dark line existed between the 1955 and 1956 growth rings.

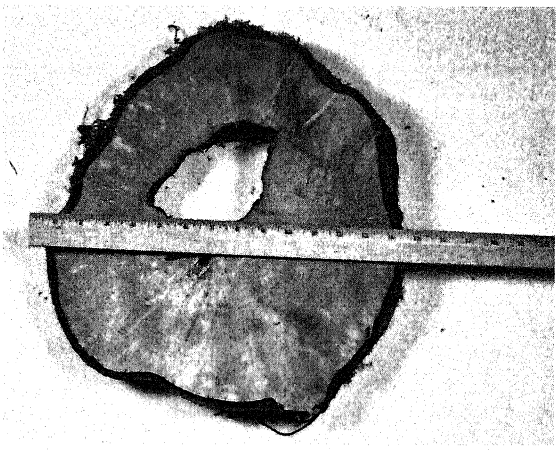

Figure 3.--Wood formed prior to the 1955 freeze contained rot in a few alder trees.

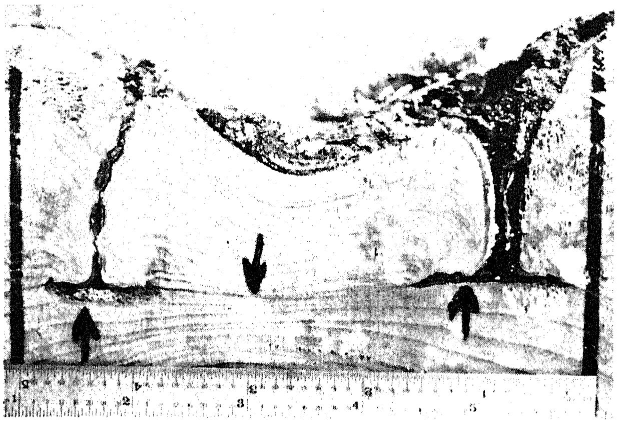

Figure 4.--The freeze resulted in partial death of the cambium of some trees.

counted with the aid of an illuminated magnifier or a dissecting binocular microscope. We were also able to check for occurrence of discontinuous rings (fig. 5) by scanning the entire section. With such data, we then could assess the probabilities of encountering false, missing, or discontinuous rings.

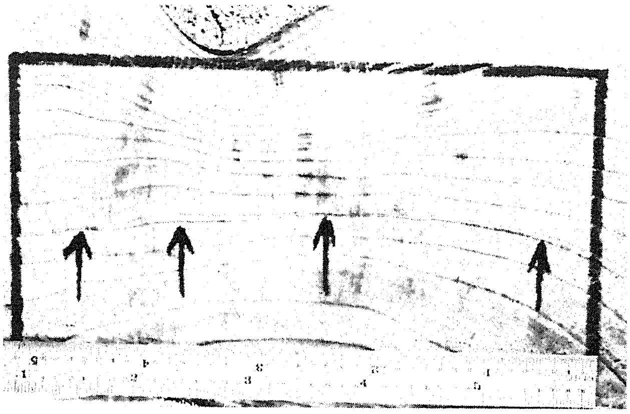

Figure 5.--Rings produced during the 1956 growing season were discontinuous and/or extremely narrowed on a few cross-sections, particularly those cut near the root-collar.

RESULTS AND DISCUSSION

We were able to locate the 1956 ring with confidence on sections from 54 trees (49 percent of all trees sampled). Tree characteristics for these sections were similar to the population originally sampled--age (30 to 79 years), breast high diameter (8.0 to 15.0 inches), and height (53 to 112 feet). Both stump and root collar cross-sections as well as all crown classes were well represented. Some trees on every site showed effects of the 1955 freeze. Thus, it seems unlikely that the selection criterion (presence of freeze-affected tissue) essential to our procedures led to any additional biases.

Although rings were close together and indistinct on several samples, use of slanting sections and/or a binocular microscope enabled us to make ring counts on all 54 sections with observable freeze damage.

Results of our ring examinations are listed in table 2. The correct number of entire annual rings was observed on sections from 46 trees

Table 2--*Results of ring examination on two types of cross-sections from red alder trees on 14 sites*

Location	Type of cross section	Number of trees with				Total rings examined	Percentage of abnormal rings
		Easily identified 1956 ring	Correct number of rings (21)	Abnormal rings			
				Number	Kind		
Waddell Creek Road	Root collar	1	0	1	Missing	21	4.8
Powderhouse Road	Root collar	4	2	2	Discontinuous	84	2.4
North Creek	Root collar	4	3	1	False	84	1.2
Cedar Creek	Root collar	4	4	0		84	0
Upper Sherman Valley	Root collar	3	2	1	False	63	1.6
Lower Sherman Valley	Root collar	2	0	2	Discontinuous	42	4.8
Subtotal	Root collar	18	11	7	Abnormal	378	1.9
McKenny	Stump	6	5	1	Discontinuous	126	.8
Porter	Stump	5	5	0		105	0
Rock Candy	Stump	5	5	0		105	0
McCleary	Stump	5	5	0		105	0
Taylor Towne	Stump	3	3	0		63	0
Schafer Park	Stump	6	6	0		126	0
Stillwater	Stump	3	3	0		63	0
Waddell Flat	Stump	3	3	0		63	0
Subtotal	Stump	36	35	1	Abnormal	756	.1
Total	Root collar and stump	54	46	8	Abnormal	1,134	.7

(85 percent). False rings were found on two trees; discontinuous or partial rings were found on five trees; and a ring was missing on one tree.

Of the eight trees with some type of abnormal ring growth, only one involved a typical section cut at stump height. In this case, the 1956 annual ring was discontinuous. The other seven trees had been examined via root collar sections. Apparently ring production is more irregular in the fluted basal section near ground level. Only eight abnormal rings (i.e., from the standpoint of age determination) were encountered in our examination of a total of more than 1,100 rings (0.7 percent). Considering only sections collected at stump height, we found only one abnormal ring in a total of nearly 800 examined rings (0.1 percent). Therefore, errors in age determination of red alder caused by abnormal rings appear to be relatively insignificant, especially for dominant and codominant trees at ages similar to those sampled in this study.

In view of these findings, we do *not* recommend using the years since site disturbance or age of adjacent Douglas-fir to estimate age of red alder. Our work (see footnote 2) and that of Tessier and Smith (1961) and Stubblefield and Oliver (1978) has shown that alder can be younger and sometimes more variable than adjacent conifers. Such age discrepancies probably result from differences in coincidental timing of abundant crops of viable seed and favorable seed bed and climatic conditions for establishment of the various species. Using years since site disturbance or conifer age to estimate alder age may lead to erroneous interpretations and conclusions regarding the formation, structure, and development of alder and mixed alder-conifer stands.

We do concur with Smith (1978) in that comparing alder ages with age since disturbance or age of adjacent or associated conifers is desirable, however. If ages differ greatly for no apparent reason, one may want to recheck ring counts on both alder and conifers.

CONCLUSIONS AND RECOMMENDATIONS

Our work suggests that missing, discontinuous, and false rings are negligible problems in determining the correct age of alder trees less than 80 years old. Indistinctness and closeness of rings in some trees appear to be far more serious problems and make counting rather difficult. To minimize such problems, we recommend the following procedures:

1. Sample only dominant and vigorous codominant trees.

2. Cut disks at stump height (stay above the fluted basal section) or breast height (if interested primarily in breast-high age).

3. Plane disk to obtain a smooth surface.

4. If rings are very closely spaced, make a slanted cut with razor blade or gouge chisel to increase "apparent ring width."

5. Apply water or petroleum jelly (Oliver 1975) to the surface to enhance ring visibility.

6. Provide good lighting and magnification.

We recognize that many foresters have neither the time or the need to use the above methods which are rather time consuming. In view of the limited number of abnormal rings found in our study, counts made carefully on increment cores extracted at breast height (and properly adjusted for years needed to attain that height) should also provide a reliable assessment of age. We recommend making a smooth razor cut along one or two sides of the core while it is still moist. Color will begin to develop (caused by oxidation of phenols) in less than one-half hour. Rings are most easily read before the core is completely dry. Ages can be substantiated by counting rings on more than one core per tree or on more than one side of each core and by

checking counts against some reference year (e.g., the 1955 freeze), or by other cross-dating techniques (Stokes and Smiley 1968).

METRIC EQUIVALENTS

1 inch = 2.54 centimeters
1 foot = 0.305 meter
1 mile = 1.609 kilometers

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